Exploring climate model large ensembles with explainable neural networks

Zachary Labe*†[1] and Elizabeth Barnes[1]

[1]Colorado State University [Fort Collins] – Colorado State University, Fort Collins, Colorado 80523 USA, United States

Abstract

To identify differences in the patterns of climate signals between large ensemble simulations, we train artificial neural networks (ANNs) to identify simple metadata-like information (such as the year and climate model name) for every input map of annual mean near-surface air temperature. While the ANN output itself is not very interesting, we show that a machine learning explainability method called layer-wise relevance propagation (LRP) can be used to understand how the nonlinear ANNs are making their predictions. In two separate examples, we demonstrate how LRP can be used to reveal time-varying regional responses to external forcings (greenhouse gases and aerosols) and for comparing unique differences between global climate models. Finally, after training on data from separate large ensembles, we evaluate our ANNs using maps from atmospheric reanalysis to isolate and compare forced temperature patterns in historical observations.

Keywords: explainable AI, machine learning, large ensembles, climate forcings, climate models

*Speaker

†Corresponding author: zmlabe@rams.colostate.edu